

SANDIA NATIONAL LABORATORIES

# Partnerships

ANNUAL REPORT FY2017



Creating a Biomaterials  
Business Opportunity



Sandia  
National  
Laboratories



“American technologies have fundamentally changed the course of human history, and DOE technologies have been an important contribution to this legacy. Sandia has a long history of successful partnerships with the private sector and universities—and is well-positioned to lead collaborations in critical and essential areas of technology for the 21st century.”

— **Rochelle Blaustein**

*Deputy Director, Office of Technology Transitions  
U.S. Department of Energy (DOE)*



“Partnerships are essential for achieving mission success and help to accelerate the commercialization of new and innovative technologies in support of economic competitiveness for our nation.”

— **Dan Sanchez**

*DOE Technology Partnerships Manager  
NNSA Sandia Field Office*

“Sandia’s Partnerships Program ensures that leading-edge technologies developed at the Labs reach the marketplace to strengthen national security and increase U.S. economic prosperity and competitiveness. We are committed to strategic partnerships to enhance and accelerate technology transfer.”

— **Steve Younger**

*Laboratories Director  
Sandia National Laboratories*



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**About the cover:**  
Sandia Postdoc Fang Liu instructs Sandia Intern Anna-Maria Hadjilambri on protocols for determination of sugar and protein content from algae biomass hydrolysates.  
See story on page 18.





“Through strategic partnerships, we strengthen the science and engineering foundation of the Labs. These partnerships with industry, academia, and other national laboratories help Sandia deliver on its national security mission. When we combine our specialized facilities and expertise with that of others, we can solve big problems of national importance.”

— Susan Seestrom

*Associate Laboratories Director & Chief Research Officer  
Advanced Science and Technology  
Sandia National Laboratories*



“By partnering with universities and other research institutions, Sandia is able to leverage its own strengths and address national challenges beyond the scope of a single institution. Partnering with academia helps develop budding engineering talent and expose Sandia researchers to new technologies and ideas.”

— Grant Heffelfinger

*Director  
Research & Development Science and Engineering  
Sandia National Laboratories*



“There is a long history of partnering with industry at Sandia. The results have been technology that is transferred and manufactured, then used to improve national security and U.S. commercial competitiveness. Sandia benefits, too, using what is learned through industrial partnerships to address national security mission requirements.”

— Mary Monson

*Senior Manager  
Technology Partnerships & Business Development  
Sandia National Laboratories*

## Partnerships by the Numbers

Sandia National Laboratories has a long and productive history of technology partnerships. These strategic partnerships strengthen the Laboratories and address national challenges.

Since the early '90s, when the DOE began technology transfer programs at the Labs, Sandia has been using partnerships as a way to leverage capabilities and deliver on its national security mission. The number and strength of these partnerships is remarkable.

Currently, Sandia has 1787 active patents in the U.S. and other countries. Looking at FY2017, Sandia had 1925 active licensing agreements spread across 47 states, as well as active agreements in more than 60 foreign countries. Software development led to 1043 active copyright assertions.

Industrial partnerships lasting for more than two decades are profiled in this year's annual report. New and long-term partnerships with companies, universities, other government agencies, and national laboratories are also featured, including collaborations that are:

- Coordinating computer hardware improvements with software to speed up simulations vital for scientific and industrial research
- Revolutionizing cybersecurity by commercializing computer processors based on neuroscience
- Studying hydrogen embrittlement to improve lifetime assessment of gas transfer systems reservoirs used to store isotopes such as tritium
- Using artificial intelligence methods to improve the analysis of public health data and protect the nation from emerging threats
- Accelerating materials discovery and developing the next generation of materials scientists

Strategic partnerships help Sandia deliver on key national security programs. They foster basic research and strengthen the Labs' science and engineering foundation. Partnerships also facilitate technology transfer, which contributes to the public good and economic well-being of the nation.



Look for the LDRD logo in this report to discover which technologies grew out of the LDRD program.

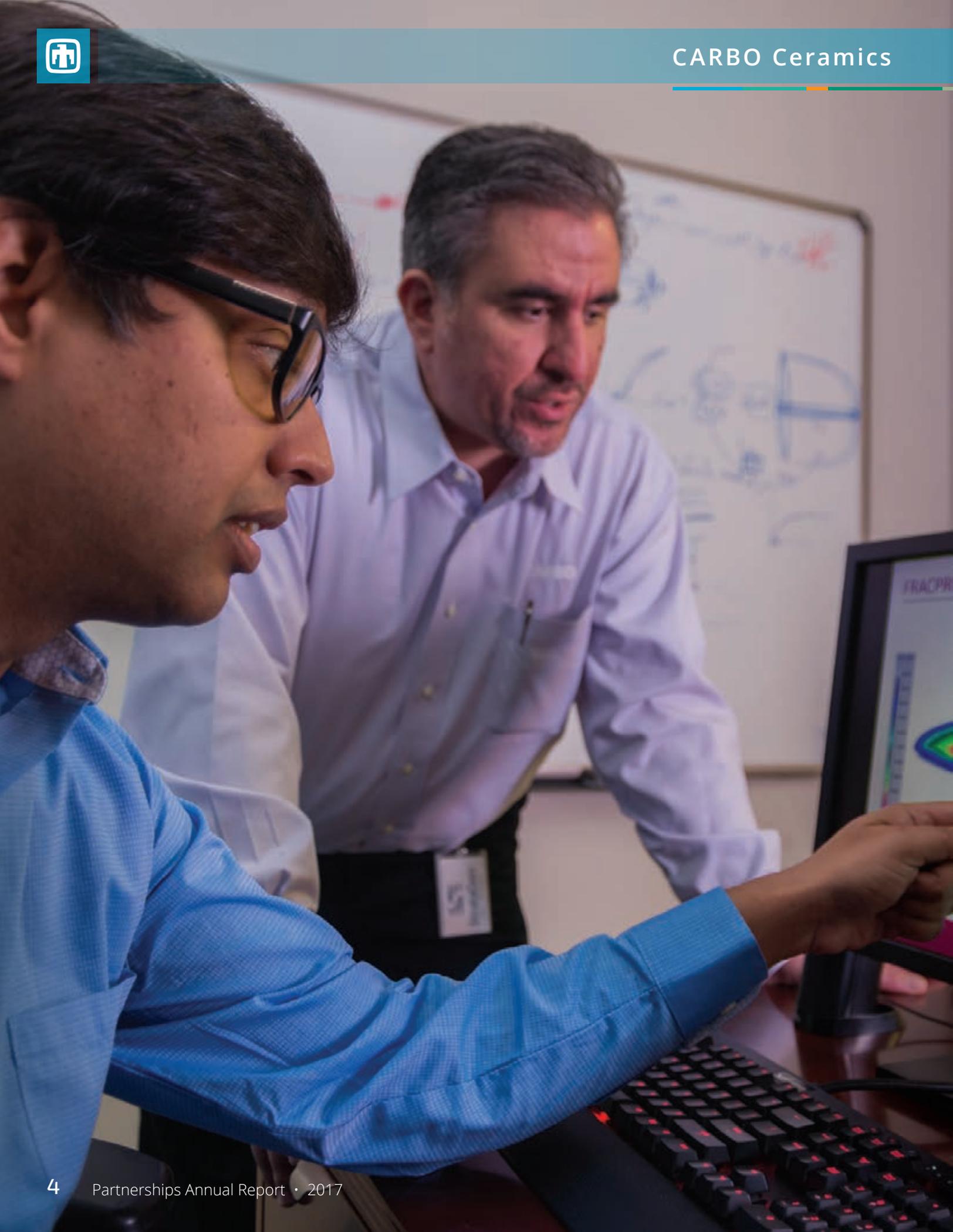


To learn more, visit [www.sandia.gov/ldr](http://www.sandia.gov/ldr)

## LDRD Program Benefits Partnerships

Research conducted within the Laboratory Directed Research and Development (LDRD) program is essential to maintaining the vitality of Sandia's mission-critical science, technology, and engineering capabilities. The LDRD program has benefited Sandia's work in all of its national security mission areas, including nuclear security, energy security, and global security.

The Labs and its strategic partners gain from collaborative research results. Many technological breakthroughs originating from, or improved through the LDRD program are later transferred to industry, commercialized under licensing agreements, and brought to market for the U.S. public good.

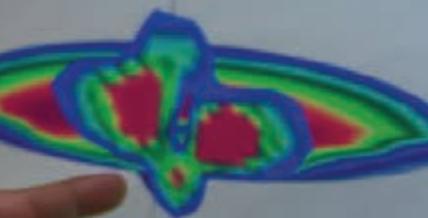


“Our partnership with Sandia has allowed CARBO to lead the industry in far-field proppant detection, which will ultimately help operators increase oil & gas recovery in their fields.”

— Terry Palisch

Global Engineering Director  
CARBO Ceramics, Inc.

Model vs. Tx100 B-Field Image



CARBO scientists Wadhah Al-Tailji and Souvik Mukherjee review the propped reservoir volume from a recent field test.

## Maximizing Oil and Gas Production with a New Methodology

### CHALLENGE

The oil and gas industry pumps proppant, materials like sand or man-made ceramics, down wellbores and into formations to keep created hydraulic fractures open when producing petroleum fluids. Oil and gas flow from wherever the proppant is located in a formation back to the wellbore. Knowing the proppant location would help operators maximize oil and gas production.

But where is the proppant going in large, horizontally drilled wells? Engineers have been using models and microseismic technology for years to infer the location of proppant. But those methods only show the location of the fractures, not where the proppant is in those fractures.

### COLLABORATION

CARBO is a proppant manufacturer and production enhancement solutions provider. They help clients optimize hydrocarbon recovery from oil and gas wells. Although they had a product that could locate proppant near the wellbore, the industry lacked the ability to locate proppant that had traveled long distances away from the wellbore.

For help solving this challenge, CARBO turned to Sandia National Laboratories. The company knew that Sandia had experience with both advanced materials and subsurface geophysical detection and modeling. Sandia proposed several possible solutions and CARBO chose electromagnetic detection. This method injects an electric current into a well and measures the electromagnetic fields returning from the subsurface with sensors located at the surface.

### SOLUTION

Once a detection method was chosen, CARBO worked with Sandia to develop a compatible proppant and the methods to locate it. Sandia researchers used their capabilities in geophysical modeling, as well as the capabilities of the University of New Mexico's Advanced Materials Laboratory, to help CARBO investigate an electrically conductive proppant. Sandia also developed the geophysics-based algorithms that would be used to convert the collected electromagnetic data into an image showing where the proppant was located deep inside fractures.

### IMPACT

CARBO has jointly developed patented technology with Sandia and published two papers with the Society of Petroleum Engineers about proppant detection using electromagnetic methods. The methodology has been tested on several wells to date and continues to be refined.

QUANTUM™, CARBO's propped reservoir volume imaging service which locates their newly developed iON™ proppant, is planned for introduction in 2018. There is already tremendous client interest in using the new methodology which promises to help optimize oil and gas production. The data and images from this service will help CARBO clients better understand how their wells are producing, and where the oil and gas are coming from. This will improve how oil and gas wells are planned, developed, and completed.

**PARTNERSHIP TYPE:** Cooperative Research and Development Agreement (CRADA) and License

**GOAL:** Maximizing oil and gas production through the use of a new proppant detection methodology



“Development of Lynx is a shining example of industry-national lab cooperation meeting U.S. and allied airborne surveillance needs. The interface improvements have increased the usage of the radar exponentially. More and more mission successes are being directly attributed to the radar.”

— John Fanelle  
Senior Director  
Radar Systems  
General Atomics  
Aeronautical Systems, Inc.

GA-ASI Field Engineers testing the new Claw interface for the Lynx radar.

## A New Interface Moves a Radar System's Usability from F to A+

### CHALLENGE

A user interface should guide people through interacting with software, making it easy to use. Longtime Sandia National Laboratories partner, General Atomics Aeronautical Systems, Inc. (GA-ASI), found that its Lynx® Multi-mode Radar Systems were being underutilized due to the overly complicated Claw® interface which was difficult for operators to learn and use.

Like so many systems in the sensor workplace, the end user voice was absent when Claw was designed. Now Sandia and GA-ASI are working together to change that.

### COLLABORATION

GA-ASI, an affiliate of privately-held General Atomics, is a leading manufacturer of Remotely Piloted Aircraft (RPA) systems, radars, and electro-optic and related mission systems. Sandia and GA-ASI have been working together since 1996 to advance the performance of the Lynx radar. The partnership focused exclusively on sensor hardware and software until 2015, when GA-ASI heard from its U.S. Air Force customer that the Lynx interface was frustrating for operators to use.

Sandia has expertise in human-system interaction, so a team began working with GA-ASI's software engineers to enhance the usability of the radar by improving its Claw interface. Meanwhile, other teams continued work on hardware and software improvements.

### SOLUTION

In assessing the Claw interface, Sandia's experts realized that a steady stream of technical advances had been added to the Lynx. However, Claw was more oriented around engineering requirements than the needs of users.

No remote sensing team sets out to create a frustrating interface. But usability is not widely applied in the sensor engineering world. The Sandia team provided its GA-ASI counterparts with a crash course in system usability research. By applying human-computer interaction principles, the GA-ASI team was able to design an interface that met customer expectations and a tight deadline.

### IMPACT

By making the interface more operator-centric, the system's usability score went from F to A+. The Air Force is pleased to have an interface that enhances the usability of the Lynx radar in high-workload, high-stress mission environments. As one Air Force crew member remarked, “The new interface is so easy to use, my kindergarten daughter could figure it out.”

This CRADA is a model for national laboratory-industry collaborations that enhance contributions to national security. Over the life of the CRADA, there have been seven new patents and patents pending, including five jointly between Sandia and GA-ASI. Many CRADA developments have now found their way into other Sandia radar systems, benefiting Sandia partners and customers such as the U.S. Navy, U.S. DoD Unified Combatant Commands, and the U.S. intelligence community.

**PARTNERSHIP TYPE:** Cooperative Research and Development Agreement (CRADA) and License

**GOAL:** Creating a simplified interface for the Lynx radar to make it easier to use in high-stress mission environments



LAMMPS

Sandia National Laboratories



“Sandia has world-class physicists, mathematicians, and computer scientists. It is a pleasure to be a part of such an outstanding team while knowing the impact this work has for the nation.”

— Mike Brown

Senior Software Engineer  
Intel

## Hardware and Software Collaboration Speeds Computing Rates and Research

### CHALLENGE

Molecular dynamics simulations are used to create new or improved materials, increase the efficiency of manufacturing processes, develop new medicines, and create approaches to protect against chemical and biological threats.

These simulations require immense amounts of computational power and speed. Although computer hardware and software continue to improve, ever more realistic simulations are required in many disciplines.

High Performance Computing (HPC) is moving towards exascale, or systems that are able to make a quintillion calculations per second, at least 50 times faster than the most powerful computers today. Yet many technical challenges remain. Computer applications must be optimized to work on the latest multicore computer processors so that simulations can keep up with research needs.

### COLLABORATION

Sandia National Laboratories is a leader in the development of massively parallel codes such as the Large-scale Atomic/Molecular Massively Parallel Simulator (LAMMPS). An open-source code developed and maintained by Sandia, LAMMPS has become popular for a large community of researchers at DOE facilities, as well as in academia and industry.

As Intel engineers new computer hardware solutions, they are working with Sandia to optimize LAMMPS code to run simulations faster with the newest technologies in the Intel Scalable System Framework. Intel’s programming model helps in the development of code that enables scientists to perform research that has been previously inaccessible due to computing limitations.

### SOLUTION

Collaboration between Sandia and Intel has led to optimized LAMMPS software that can exploit the newest Intel technologies including fast and energy-efficient processors, network fabric connecting many processors for HPC, and storage solutions that can house complex simulation data.

### IMPACT

For some types of simulations the new hardware and software solutions facilitate simulation rates that can be over nine times faster than those achieved only two years ago. These faster computing rates enable scientists to investigate new problems.

Results of the Sandia-Intel collaboration are helping to maintain U.S. leadership in HPC in the face of global competition. They are also moving the country closer to achieving the goals of the DOE Exascale Computing Project, which is designed to address challenges in scientific discovery, energy assurance, economic competitiveness, and national security. This project is helping discover insights and answers to crucial scientific and technology challenges in areas including nuclear energy, climate, wind energy, combustion, chemical science, precision medicine for cancer, cosmology, astrophysics, and more.

Sandians Steve Plimpton, Veena Tikare, Si Hammond, and Aidan Thompson reviewing a LAMMPS simulation of a shock front progressing through an energetic material.

**PARTNERSHIP TYPE:** Cooperative Research and Development Agreement (CRADA) and License

**GOAL:** Coordinating computer hardware improvements with software to speed up simulations vital for scientific and industrial research



“The technical breadth of Sandia and domains where they have world-class expertise is very impressive. It’s an ideal environment for incubating novel, disruptive technologies like the Neuromorphic Cyber Microscope.”

— David Follett  
CEO  
Lewis Rhodes Labs

Sandia Researchers Roger Suppona and John Naegle, and Lewis Rhodes Labs CEO David Follett examine their Neuromorphic Cyber Microscope.

## Neuromorphic Cyber Microscope Mimics the Brain to Improve Cybersecurity

### CHALLENGE

Protecting our computer systems from malicious attacks has become a national problem. We regularly hear of successful cyber attacks against industry and government targets. While a general-purpose computer is very good at many tasks, it is inefficient at looking for patterns in a massive stream of data.

It takes a huge amount of computer power, time, and money to look at the patterns in the massive flow of data. Extensive expertise about how the brain analyzes information was used to develop a more efficient data analysis architecture.

### COLLABORATION

Addressing one of computer science’s holy grails, the Neuromorphic Cyber Microscope required the collective expertise of Sandia National Laboratories and Lewis Rhodes Labs (LRL). Sandia and LRL maintain a close research partnership dating from 2010, with Sandia providing critical domain expertise in cybersecurity to complement LRL’s core excellence in neuromorphic computing.

The processor in the Cyber Microscope is based on the neuroscience research of Pamela Follett, a co-founder of LRL. Follett is a pediatric neurologist and neuroscientist who studies developmental diseases, such as cerebral palsy in children. Her husband, David Follett, co-founder and CEO of LRL, used her work as the basis for a computational model of how the brain processes information.

### SOLUTION

Comparing brains with cerebral palsy to healthy brains was critical to the deeper insights. Neuromorphic processors are designed around a unique understanding of how the sensory cortex of the brain processes streams of data in parallel. The Neuromorphic Cyber Microscope does not imitate brain functionality in detail, but leverages the structural architecture of the brain to achieve tremendous performance and efficiency gains in processing streaming data. In fact, it’s more than 100 times faster and 1,000 times more energy-efficient than racks of conventional cybersecurity systems.

### IMPACT

The Cyber Microscope directly addresses a \$7 billion opportunity in the \$75 billion cybersecurity market—a market strategically critical to U.S. security and competitiveness. Fundamental to this breakthrough is the invention and productization of the world’s first commercially viable neuromorphic processor.

While the technology is currently being used to address the national-level issue of cybersecurity, the underlying technology is useful in applications ranging from big data analysis to image processing acceleration. Pattern matching is pervasive in markets including finance, social media, and government. The Neuromorphic Cyber Microscope profoundly alters the economics of cybersecurity by leveraging concepts derived directly from the neuroscience of the brain’s sensory cortex. These devices offer unparalleled power, size, weight, and cost benefits over traditional architectures.

**PARTNERSHIP TYPE:** Collaborative Research supported by the Hardware Acceleration of Adaptive Neural Algorithms (HAANA) Grand Challenge LDRD

**GOAL:** Revolutionizing cybersecurity by commercializing computer processors based on neuroscience



“Public health surveillance is ripe for innovative ways to learn from data that occur as text, especially using machine learning. This joint work with Sandia allowed CDC and Sandia both to explore and prove methods that we’re eager to introduce back into surveillance practice.”

— Chad Heilig

*Associate Director  
for Data Science  
Center for Surveillance,  
Epidemiology, and  
Laboratory Services  
Centers for Disease  
Control and Prevention*

Sandia Researchers Pat Finley and Drew Levin are working with the CDC so that data from hospital emergency departments can be used more effectively to protect the nation from disease threats.

## Using Machine Learning to Protect the Nation from Health Threats

### CHALLENGE

The Centers for Disease Control and Prevention (CDC) coordinates a national public health surveillance system to provide early warning of diseases or biological weapons attack. The system identifies unusual symptoms from massive quantities of data coming from hospital emergency departments across the nation. Traditional statistical methods for surveillance are good at finding disease outbreaks if you know what you’re looking for, such as seasonal flu. But they don’t work as well for finding novel cases, like a new disease, opioid abuse, or a bio-weapon that hasn’t been encountered before.

### COLLABORATION

CDC is responsible for protecting the nation from health and safety threats. A CDC data science group is pioneering the use of machine learning (ML) for epidemiological purposes. Sandia National Laboratories is known for excellence in developing ML algorithms and high performance computing.

Researchers from both organizations saw potential value in teaming up to tackle challenging public health problems. Through conference calls and extended in-person meetings, CDC and Sandia scientists brainstormed new ML approaches that could improve results from health-record data, and then built prototype applications to test their hunches.

### SOLUTION

Together, the partners have developed powerful new approaches and algorithms for identifying signals in health records. Utilizing millions of records from hospital emergency departments, Sandia and the CDC are looking at both diagnostic codes and text written by health providers about patient symptoms. These ML algorithms excel at finding patterns in textual data such as physician notes, in spite of abbreviations, misspellings, and variations in words and phrases used at different hospitals. ML-based data fusion—combining different categories of information such as text and numbers—can better find subtle patterns in health data.

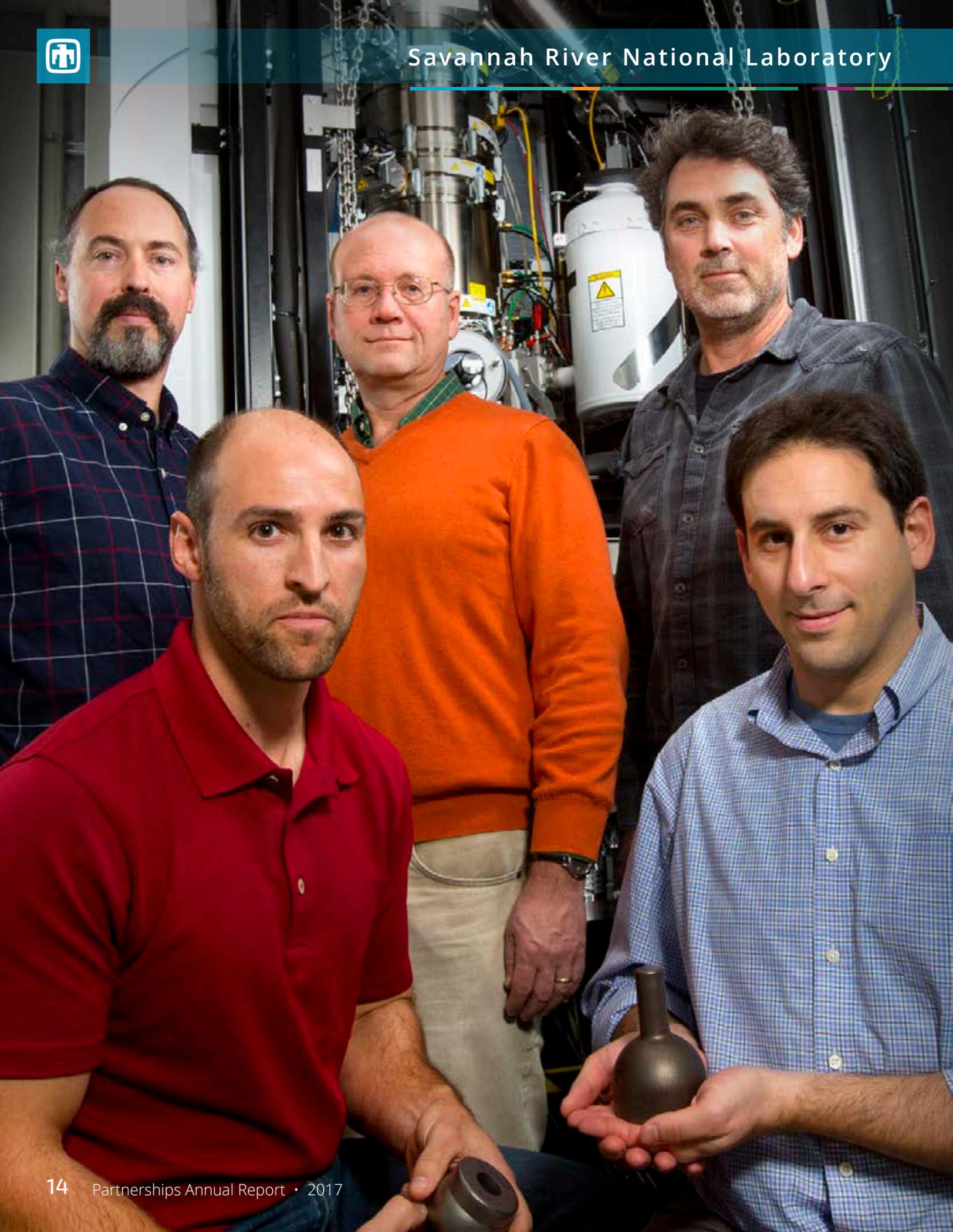
### IMPACT

New ML methods detect some anomalies in health data better than traditional methods; the algorithms can also adapt as health issues and indicators change over time. Thus ML-based systems can potentially find evidence of known diseases, and clues to emerging ones. Methods developed within this partnership could eventually better protect the nation from disease threats.

Although the team originally focused on improving national-scale disease surveillance, researchers are now working to identify other public health issues that could benefit from the research. Artificial intelligence, supported by ML methods, can potentially provide faster and more accurate results for a host of health-data analysis problems, such as identifying autism spectrum disorder from students’ behavioral evaluations and finding early signs of suicidal intent from patient records to enable earlier intervention.

**PARTNERSHIP TYPE:** Collaborative Research

**GOAL:** Using artificial intelligence methods to improve the analysis of public health data and protect the nation from emerging threats



“By taking advantage of our complementary capabilities, research on embrittlement phenomena will be more efficient, which can only lead to better and more effective predictive models.”

— Michael Morgan

*Senior Fellow Scientist  
Savannah River  
National Laboratory*

Sandia Researchers Joe Ronevich and Josh Sugar hold GTS steel reservoir forgings while other members of the Sandia team, Dorian Balch, Douglas Medlin, and Chris San Marchi, stand behind them and in front of the new scanning transmission electron microscope used to examine microstructural damage caused by tritium aging.

## Researching Hydrogen Embrittlement to Improve Steel Reservoirs

### CHALLENGE

Stainless steel gas transfer systems (GTS) reservoirs are used to store hydrogen isotopes including radioactive tritium, at high pressure. But over time, hydrogen isotopes dissolve into steel, degrading the material and reducing its fracture resistance, a process called embrittlement.

How can engineers more accurately predict the integrity of the GTS reservoirs, and, if possible, safely extend their useful lifetime? Although the mechanical properties of the steel reservoirs can be measured today, these properties will be different years from now due to the ongoing decay of tritium into helium bubbles that damage the steel. At present, this aging process is not understood well enough to be incorporated into predictive models for steel reservoirs, motivating the need for research into the underlying mechanisms.

### COLLABORATION

In response, Sandia National Laboratories and Savannah River National Laboratory (SRNL) have established a collaboration to address this challenge. Sandia has R&D expertise and capabilities in fracture mechanics and hydrogen embrittlement within the Hydrogen Effects on Materials Laboratory (HEML). Combined efforts of the HEML along with advanced microscopy have been utilized to support engineering design and predict reservoir performance. SRNL is one of only a few national laboratories with capabilities to work with tritium. SRNL has expertise in fracture mechanics in addition to experience with tritium embrittlement, and unique capabilities to expose, age, and test tritium-exposed matter.

By teaming up with SRNL, Sandia is able to leverage their combined unique capabilities and expertise to test and evaluate the mechanical properties of steels exposed to tritium. These results will be used to understand the aging mechanisms of tritium degradation in steels.

### SOLUTION

In order to improve predictive capabilities, Sandia and SRNL are combining mechanical testing with detailed advanced microscopy of the steels exposed to hydrogen isotopes. It takes several years to build in helium concentrations from the decay of tritium; however, strategic design of experiments has allowed researchers to kick-start a testing campaign which will provide valuable fundamental understanding of degradation mechanisms in coming years.

### IMPACT

This collaboration will ultimately deliver validated models that can be used to perform lifetime assessment of GTS reservoirs. The knowledge generated can potentially be used to examine new reservoir designs, improve the materials from which they are made, and perhaps extend the life of these components. Although this research is initially focused on predicting aging issues in nuclear weapon technologies, it could be applied more broadly, since hydrogen embrittlement is also a critical concern for other applications for hydrogen storage and delivery.

**PARTNERSHIP TYPE:** Collaborative Research

**GOAL:** Studying hydrogen embrittlement to improve lifetime assessment of gas transfer systems reservoirs used to store isotopes such as tritium



*Sandia and Georgia Tech signed a partnership MOU in 2015 to enhance research in a number of areas important to national security missions: Energy and Grid Modernization, Materials, Advanced Manufacturing, Data Science, Cyber Security and Electronics, Microsystems and Nanotechnology.*

“Georgia Tech’s strategic interactions with Sandia in materials data science and informatics builds on Tech’s emphasis on developing the 21st century workforce aimed at accelerating materials discovery, improvement, and development.”

— David McDowell

*Executive Director  
Institute for Materials,  
Georgia Institute  
of Technology*

Georgia Tech students David Montes de Oca Zapiain Jr., Xinyi Gong, Soumya Mohan, and Sezen Yucel who are working on Material Knowledge Systems for crystal plasticity and the Materials Assurance Project for stainless steels.

## Accelerating Materials Discovery and Scientist Development

### CHALLENGE

Sandia National Laboratories and the Georgia Institute of Technology (GT) share a dedication to accelerating materials discovery and development for a broad range of applications. As partners in the Academic Alliance program, they are working together on a number of research areas, including materials science. The Academic Alliance has three principal goals: solve big problems, sustain and engage human capital, and accelerate technology commercialization.

### COLLABORATION

GT is adept at developing and applying advanced mathematical techniques to understand which data out of the immense sea of disparate points collected during materials testing is important. One recent collaborative project looked at material assurance. Meeting performance requirements is important for every type of structure or product to help ensure safety because adulterated materials create risk. Remember the melamine found a few years back in pet food and infant formula?

Whether the result of a manufacturer cutting corners, or the unforeseen impact of improvements to a manufacturing process, being able to distinguish subtle compositional changes quickly, reliably, and economically is vital, particularly for mission-critical materials. For this project, the researchers studied different varieties of steel.

### SOLUTION

By combining nondestructive tests with innovative data analysis techniques, researchers are extracting the most relevant information in order to produce materials’ fingerprints. This promises to be a robust, reliable and cost-effective process. Sandia has transitioned some of these techniques to other areas based on the success of this first effort with steel. Intellectual diversity—combining the different perspectives and approaches of Sandia researchers and GT faculty and students—is generating solutions with the potential for global impact.

### IMPACT

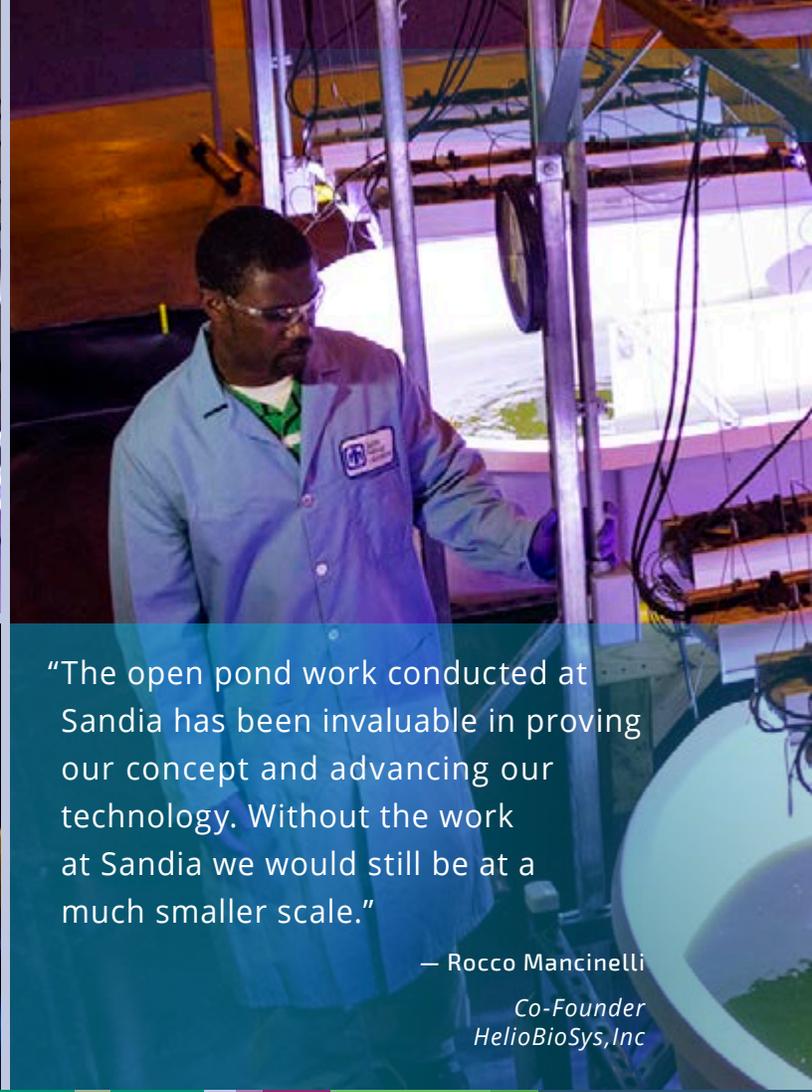
Materials assurance is critical to maintain stockpile and national security system reliability. It is also important for building everything from cars to skyscrapers, and could be instrumental in unlocking the promise of additive manufacturing for high-consequence applications.

GT is a leader in combining materials science and data analytics. This has led to their students acquiring a unique perspective on materials science and to GT becoming a national leader, working to inform manufacturing policy. Research collaborations with GT help Sandia develop and recruit top-notch materials scientists.

The results of the materials assurance collaboration with GT have included a short course taught by Professor Surya Kalidindi bringing the latest knowledge in data analytics’ use in materials science to Sandia researchers. Participation in the Academic Alliance has also led to six GT students working as student interns at Sandia in just a few years.

**PARTNERSHIP TYPE:** Collaborative Research and Academic Alliance

**GOAL:** Accelerating materials discovery and developing the next generation of materials scientists



“The open pond work conducted at Sandia has been invaluable in proving our concept and advancing our technology. Without the work at Sandia we would still be at a much smaller scale.”

— Rocco Mancinelli  
Co-Founder  
HelioBioSys, Inc

# Validating Cyanobacteria's Economic Potential



## CHALLENGE

Trying to produce cost-competitive renewable products that can compete with petroleum-based commodities like plastics is challenging. Various individual algae strains have been tried as a source material for biofuels and other products traditionally derived from petroleum. But now a consortium of cyanobacteria is being researched as an alternative. Cyanobacteria are microscopic photosynthetic bacteria, with impressive economic and production potential.

After testing their cyanobacteria consortium at a small scale in a closed system, startup company HelioBioSys needed to prove their idea at a larger scale, in an environment more closely resembling industrial-scale production.

## COLLABORATION

Sandia National Laboratories operates open, yet environmentally controlled algae ponds that are used to research promising new strains and technologies. Through a collaborative project, Sandia is helping HelioBioSys validate their cyanobacterial consortium strategy with facilities and expertise that would otherwise be unavailable to the small company.

The research is helping to reveal the roles of each cyanobacteria strain within the consortium, so growing strategies can be fine-tuned to optimize production. The pilot-scale environment is also proving that these cyanobacteria can be grown in open ponds without experiencing damaging contamination from “spectator” species (unintentionally introduced microorganisms). At the same time the pilot is evaluating the impacts of different nutrient (nitrogen, carbon dioxide) addition levels, and harvesting strategies.



## SOLUTION

The two founders of HelioBioSys came up with the idea of using a cyanobacterial consortium as a source of fermentable sugars for biofuels. Their trio of cyanobacteria coexist in a system resembling those in nature, as each species fills a niche and has a synergistic relationship with the others. The cyanobacteria produce a variety of polysaccharides that can be processed into biofuels and sustainable biomaterials, including plastics.

The cyanobacteria consortium has shown higher product concentrations than those typically observed with microalgae, but does not require expensive fertilizers or nutrients as the cyanobacteria fix  $N_2$  and  $CO_2$  directly from air. Harvesting is easier, too, as the organisms secrete their sugars directly into the water, forming a gel at the appropriate pH. Polysaccharides and biomass can be harvested separately or together, depending on the intended end product.

## IMPACT

The HelioBioSys cyanobacteria are producing concentrations of bioproducts more than double those that are common with algae. They are achieving these superior product concentrations with lower production costs.

This collaborative project with Sandia is giving HelioBioSys metrics to justify proceeding to large scale commercial production. It is creating a new biomaterials-based industry opportunity and also a petroleum displacement strategy for U.S. energy security.

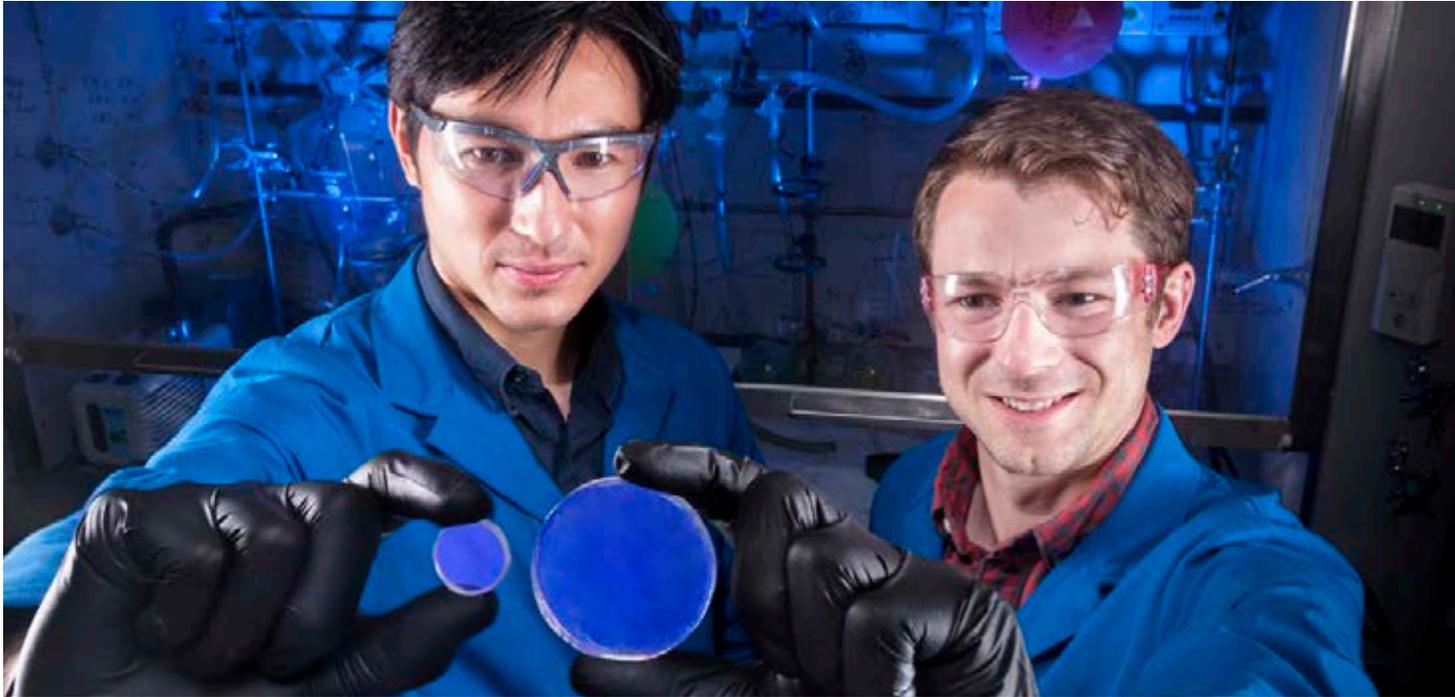
■ Sandia Researchers Eric Monroe, James Jaryenneh, Tyler Eckles, Pamela Lane, and Peter McIlroy operate raceways growing a consortium of cyanobacteria.

**PARTNERSHIP TYPE:** Cooperative Research and Development Agreement (CRADA) and DOE Small Business Voucher (SBV)

**GOAL:** Validating the techno-economic feasibility of using cyanobacteria to produce cost-competitive, bio-based petroleum-displacing products



## New Radiation Detection Materials to Increase National Security



The Radiation Detection Laboratory (Rad Lab) at Sandia National Laboratories, California, creates materials and detector systems to improve the ability of first responders, homeland security, and border security to assess threats and keep our country safe. The facility houses a radiation lab, where characterization work is done with radioactive sources, and a chemistry lab, where materials are synthesized.

One of the Rad Lab's projects is developing a new class of organic glass scintillators for detecting nuclear threats. Researchers are developing this novel, neutron-sensitive scintillator in order to better differentiate between nuclear materials that could be potential threats and normal, non-threatening sources of radiation.

Currently, scintillators are either made from incredibly expensive fragile trans-stilbene, or inexpensive plastic that isn't as good at detection. Plastic monitors widely in use at America's borders and ports have limited detection ability and suffer from frequent false alarms caused by normal background radiation or medical radioactive material.

To move the organic glass technology towards commercialization, the Rad Lab team is working with a number of industry, laboratory, and university partners that possess complementary capabilities. At Cal Poly San Luis Obispo, a professor is working to incorporate polymers into the materials to improve their properties and make them stronger. Researchers at Lawrence Berkeley National Laboratory are testing these glasses using specialized scintillation characterization equipment.

XIA, a company that invents, develops, and markets advanced digital data acquisition and processing systems for radiation detector applications, is collaborating with Sandia to build a complete prototype device using the organic glass. With further field testing, the research team's goal is to show that organic glass scintillators can withstand the environmental conditions found at port facilities. Then this new class of radiation detection materials would be ready to help increase national security.

**Sandia Researcher Patrick Feng holds a trans-stilbene scintillator and Sandia Researcher Joey Carlson holds a scintillator made of organic glass. The trans-stilbene is an order of magnitude more expensive and takes longer to produce.**

## Sharing Expertise in Hazardous Material Container Testing

The Thermal Test Complex (TTC) at Sandia National Laboratories has state-of-the-art chambers providing controlled fire test environments for performance large-scale testing of components and assemblies. The facilities have a wide range of instrumentation to gather valuable data from tests conducted for fire and heat transfer research. Completed in 2006, the TTC, along with an outdoor burn site, provides advanced capabilities available nowhere else in the world to help solve high-consequence problems involving fire.

The TTC was originally built for generating data needed to verify and validate computer codes and models that are used to qualify and certify systems, whether weapons, electronic hardware, or components. But in recent years, the role of the TTC has been expanding.

Sandia has been testing hazardous material containers used for storage and transport since the 1970s. These containers store everything from medical isotopes to spent fuel from nuclear power plants. In order to ensure public safety, requirements for these containers are stringent. Industry representatives, as well as specialists from government agencies, come to the TTC to test containers as part of their design and certification process.

Thermal and container experts at Sandia started sharing their knowledge more widely with a new course focused on thermal modeling and testing of hazardous material containers. The DOE Packaging Certification program, part of the Office of Environmental Management, funded development of the class, which is offered to participants from the government and private sectors, including international participants. People taking the course include container designers, testing organization representatives, national laboratory researchers, and government regulators.

The five-day course was available again this year and is planned to be presented each November. The University of Nevada, Reno has included this course as part of their accredited Graduate Certificate in Nuclear Packaging, the only such program in the nation.



■ Sandia Technologist Vincent Valdez at an open pool fire test at the Lurance Canyon Burn Site.



## Raytheon Expands Its Presence in the Park



Raytheon Albuquerque Site Director Susan Kelly and Naval Area and Mission Defense Vice President Todd Callahan; New Mexico Governor Susana Martinez; and City of Albuquerque Director of Economic Development Gary Oppedahl.

Raytheon Company opened a new engineering facility in the Sandia Science & Technology Park. The new 72,000-square-foot building supplements their existing 103,000-square-foot facility in the SS&TP. Raytheon is expanding its operations to develop and produce range monitoring and telemetry systems for the U.S. and its allies. The expansion will bring 60 new high-tech manufacturing jobs to the state over the next six years.

The Mobile Range integrated suite of communications, optics, and telemetry capabilities can be deployed anywhere in the world—on land, at sea or in the air—with minimal support staff or infrastructure. This technology enables in-country flight testing, demonstrations, and data collection in a variety of environments and conditions.

The company employs more than 350 workers in science, engineering, advanced manufacturing and management jobs at its facilities in Albuquerque and Diné, located on the Navajo Nation. Raytheon’s Albuquerque workforce is expected to grow from 180 to 200 people by the end of the year.

“Raytheon is growing its high-tech manufacturing footprint in rural and urban New Mexico, where workers are producing vital national security technology,” said Todd Callahan, Raytheon Naval Area and Mission Defense vice president. “New Mexico has a long history of scientific excellence, and we value our strong partnership with this state.”

“We’re thrilled that Raytheon continues to expand in Albuquerque,” Albuquerque Mayor Richard Berry said. “I am pleased that they have been able to take advantage of our great workforce and through their strategic location at the SS&TP they are able to take advantage of potential collaborations with the world’s finest scientists.”

Raytheon continues to work with Sandia National Laboratories on a number of engineering projects related to the Labs’ national security mission.

### New companies in the Park in 2017:

- Comscire—The Quantum World Corporation
- Diakonon Technology Group
- Knowledge Systems (Sandia)
- New Mexico Angels
- New Mexico Start-up Factory
- Project Enhancement Corporation



To learn more about the SS&TP, visit [www.sstp.org](http://www.sstp.org)

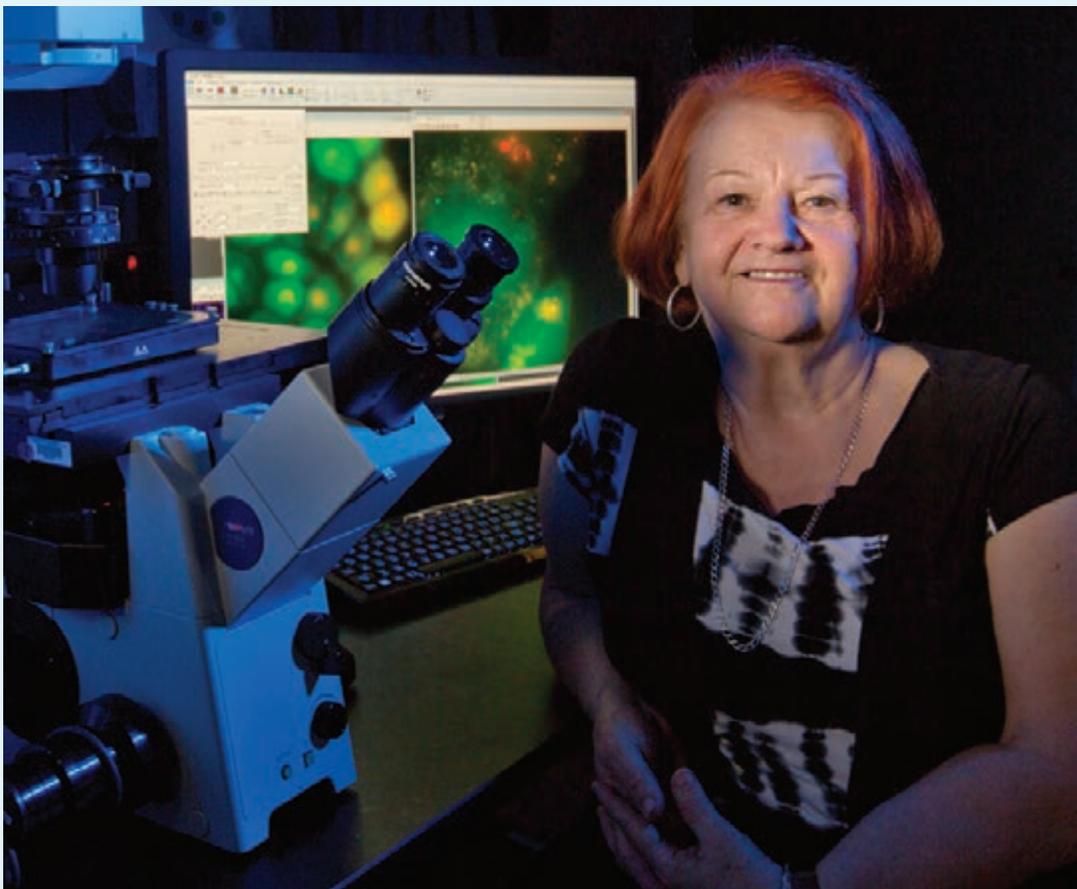
## Biopharmaceutical Company Tackles TB and Other Diseases

Biophagy, an Albuquerque biopharmaceutical company, is developing drugs that modulate autophagy for therapeutic areas with high unmet need. Autophagy is a ubiquitous process whereby cells eliminate infectious organisms and unwanted denatured materials. Its decline (often seen with aging) can exacerbate infectious and neurodegenerative diseases including tuberculosis, Alzheimer's, and Parkinson's, as well as aging symptomology.

Mary Ortner, Biophagy's president and CEO, needed specialized imaging technology to help move the research forward. Through the New Mexico Small Business Assistance (NMSBA) Program, she was paired with Sandia National Laboratories scientists Jerilyn Timlin, Meghan Dailey, and Bryan Carson. Due to their continuing work on projects relating to Sandia's biodefense mission, they had the experience and specialized hyperspectral confocal imaging equipment to demonstrate autophagy drug binding sites in a unique, highly specialized manner.

Binding patterns discovered by the Sandia scientists helped Biophagy understand and identify discrete autophagic mechanisms and establish proof of concept (POC) using a surrogate TB model, also developed by Sandia. As a result of this successful research partnership, the company has hired an additional consultant in chemistry and is now developing a proprietary chemical series for drug development against resistant strains of tuberculosis.

Ortner credits the research done with Sandia through NMSBA as being of great value as it has given Biophagy sufficient data to apply for a National Institute of Health Small Business Technology Transfer grant. The progression of research from POC to designing the company's own proprietary compounds is also creating a larger portfolio of intellectual property, making Biophagy more attractive to potential investors and pharmaceutical company partners.



■ Biophagy President and CEO Mary Ortner reviewing research findings.



To learn more about NMSBA, visit [www.NMSBAprogram.org](http://www.NMSBAprogram.org)



## Rapidly Building Custom Power Sources and a Company



Mechanical Engineer Joseph Beck always had an interest in entrepreneurship, so he completed an MBA while working at Sandia National Laboratories in the Power Sources Technology Group (PSTG). Eric Branson started at Sandia as a student intern, and continued working in various groups as he completed his MS in Chemical Engineering, before joining the PSTG.

The two formulated and matured an idea about how to accelerate power source design and development. They learned about Sandia's Entrepreneurial Separation to Transfer Technology (ESTT) program, and realized it could be a means for them to take their ideas about power source design, manufacturing, and prototyping and turn them into a business. In early 2017 they started their company, Advanced Manufactured Power Solutions (AMPS).

ESTT is a valuable tool which allows Sandia to transfer technology to the private sector by permitting Sandia employees to leave the Labs to start up or expand technology companies. Entrepreneurs are guaranteed reinstatement for up to two years if they choose to return to the Labs.

With Branson's background in design and development and Beck's in production and quality, they felt they were ready to use their experience to accelerate battery product realization, closing the gap between conceptual design and production. Sandia is a leader in batteries, and both gained experience at the Labs that can't be acquired in university classes.

At AMPS they use rapid product realization methods to design and build custom power sources for Sandia and other customers. AMPS' highly reliable power sources meet the needs of mission-critical, high-value applications in defense, aerospace, and medicine. Beck and Branson are thrilled to have the opportunity to support the Sandia national security mission and transfer technology outside the Labs while fulfilling their entrepreneurial dreams.

**AMPS Vice President and CTO Eric Branson and President and CEO Joseph Beck in the AMPS facility.**

## Joining the Entrepreneurial Ecosystem at C3 Downtown

Sandia National Laboratories' Entrepreneurial Exploration (EEx) program is designed to invigorate an entrepreneurial culture at the Labs and help fulfill Sandia's technology transfer mission. Its goal is to inspire entrepreneurs to either enter the business world or develop that mindset within the Labs.

A new office, called the Center for Collaboration and Commercialization (C3) Downtown, was opened by Sandia this year in the University of New Mexico's (UNM) Lobo Rainforest building. EEx is being managed out of this location in order to tap into the vibrant entrepreneurial ecosystem in downtown Albuquerque and to link Sandians with entrepreneurial opportunities and resources.

C3 Downtown is a place that serves as a public face for Sandia, providing access to the Labs and building linkages with the community. C3 programs and services, including EEx, maximize interaction with partners—industrial, academic, and government—and facilitate successful technology commercialization.

Community members can meet with Sandia staff at C3 Downtown to discuss Licensing, Cooperative Research and Development Agreements, Strategic Partnership Projects, New Mexico Small Business Assistance, and other technology transfer programs. C3 also hosts regular office hours with Sandia's Supplier Diversity, Community Involvement, and Government Relations departments. It is also a landing place where other Sandians can drop in and work.

"C3 Downtown brings Sandia's tech transfer team together with colleagues from UNM and the Air Force Research Laboratory. The three tech transfer organizations working together will collectively increase the impact of our work," said Susan Seestrom, Sandia's chief research officer and associate laboratories director for Advanced Science and Technology. "Working together, Sandia, the city, UNM, and all our local partners will be a powerful force spurring innovation and economic growth in our region."



Sandia Associate Labs Director Scott Aeilts, EEx Program Leader David Kistin, and NMSBA and ESTT Program Leader Genaro Montoya brief Congressman Ben Ray Luján on economic development programs.



To learn more about EEx, visit [www.C3abq.com](http://www.C3abq.com)



## Ganged Heliostats Cut Costs for Concentrating Solar



Concentrating solar power (CSP) is a promising clean energy technology which uses heliostats (large segmented mirrors) to reflect and focus the sunlight on receivers that collect solar energy. But the large initial capital outlay needed to install utility-scale plants has limited the ubiquitous adoption of CSP. The DOE SunShot initiative has set aggressive techno-economic targets for solar technologies, and Skysun ([www.skysunsolar.com](http://www.skysunsolar.com)), a startup based in Ohio, has come up with a new heliostat design that has the potential to lower the cost of CSP plants.

Skysun was one of the companies which received assistance from Sandia National Laboratories through the DOE Small Business Vouchers (SBV) program this year. SBV gives U.S. clean energy small businesses a competitive advantage in the global marketplace, and increases national lab awareness of the challenges small businesses face in the energy sector.

Sandia operates the National Solar Thermal Test Facility, where it evaluates CSP collectors and whose researchers have expertise in a variety of structural and optical modeling techniques for systems with complex geometries, especially those related to solar applications. This made the Labs well suited to assist Skysun with evaluating its small-scale prototype system. The company wanted to address mechanical and optical questions about the system's performance in windy conditions, survivability under wind loads, on-sun tracking capability, and cost feasibility.

Skysun's novel design groups multiple heliostats together using suspended guide cables. Costs are reduced as ganged heliostats can share motors and support structures instead of each heliostat needing its own. To date, it is the first ganged CSP concept to get close to achieving the SunShot Initiative's goal of lowering the cost of solar collectors to \$75/m<sup>2</sup>.

The company's founders believe Sandia's support with 11 months of testing their ganged heliostat prototypes' performance through the SBV project will help them attract potential partners. Who wouldn't be interested in the chance to cut the cost of a new CSP system by more than 30% in the near future?

**Sandia Researchers Ken Armijo, Julius Yellowhair, and Jesus Ortega with prototype heliostats and a rendering of a power tower plant using ganged heliostats shown behind them.**



*To learn more about SBV, visit [www.sbv.org](http://www.sbv.org)*

## Pitch Competition Moves Wind Energy Harvester Towards Market

On September 14, six teams of Sandia National Laboratories scientists and engineers pitched innovations to a panel of local investors and members of the entrepreneurial community. The Pitch Competition, organized by Sandia in collaboration with startup accelerator ABQid, was part of a DOE initiative called Lab-Bridge, aimed at inspiring inventors to take new lab technologies to market.

The Pitch Competition had each team choose one member to explain their research in five minutes, followed by an additional five minutes of questions from judges about costs, money savings, customers, licensing plans, business models, and industry competition. Researchers were coached ahead of time how to clearly and concisely explain their research. For some, this was their first time presenting their ideas in front of a crowd.

The panel of judges included local entrepreneurs and representatives from ABQid, engineering and manufacturing company Team Technologies, and CNM Ingenuity, a nonprofit that helps Central New Mexico Community College pursue endeavors in technology and entrepreneurship.

Pitches covered a wide range of ideas involving heat exchangers, better fuel efficiency, new software, an app tracking system, and reducing drag on cars and flying vehicles. The top prize went to Brent Houchens, Myra Blaylock, and David Maniaci, for a novel approach to distributed wind power. Houchens pitched his team's solution to distributive wind generation, Aero-MINEs (Motionless, INtegrated, Energy), which are "wind energy harvesters that have no external moving parts and are safe, reliable, quiet and totally scalable."

As next steps, the Aero-MINEs team would like to test their model in a wind tunnel, optimize their design, and license their technology for production. In addition, Houchens said the team is looking for battery storage partners and a potential early adopter. Some top retailers have committed to using more renewable energy, so that's a market Aero-MINEs can pursue first.



■ Sandia Aero-MINEs team members Myra Blaylock and David Maniaci, ABQid Executive Director T.J. Cook, Sandia Aero-MINEs team member Brent Houchens, and President and Owner of Westergaard Solutions Inc. Carsten Westergaard gather after the Pitch Competition event.



## Improving Compact Heat Exchangers for Efficient Energy Production



Microchannel heat exchangers (MCHEs) are a rapidly developing technology that enable improved performance and drastic size reductions in several industrial processes, including high efficiency power conversion such as the supercritical CO<sub>2</sub> (sCO<sub>2</sub>) Brayton cycle and hydrogen fueling stations. While microchannels excel at providing a lot of heat transfer in a small package, they have their challenges. The small channels (around 1 mm) can get clogged with debris, and cleaning them interrupts the industrial process where they are being used.

Sandia National Laboratories was awarded five DOE Technology Commercialization Fund (TCF) projects this year, including one for improvements to MCHEs. Each energy-related TCF project pairs lab researchers with industry partners who are evaluating lab-developed technologies that fit their business models.

This MCHC project is an avenue for refining designs to make cleaning the microchannels much easier while improving flow uniformity and lowering manufacturing costs. Sandia and Vacuum Processing Engineering, Inc. (VPE) are collaboratively working on envisioning solutions based on Sandia intellectual property, selecting the best concepts, designing a prototype, and evaluating it.

Sandia has been developing an understanding of the fundamental physics in MCHEs using analysis, simulations, and experiments. Researchers have been assisting VPE for several years to take their decades of advanced manufacturing experience and apply it to making MCHEs. This collaboration has helped VPE become an experienced domestic supplier of this efficient, high performing equipment and provided Sandia and industry with specialized heat exchangers.

Currently, Sandia and VPE have four DOE-funded projects totaling \$1 million, including this TCF project. These projects are aimed at improving MCHC designs for cleaning, exploring additive manufacturing's potential to lower cost and improve performance, simulating internal stresses using high performance computing, and testing prototypes under extreme operating conditions.

VPE MCHE team members Kyle Zada, Aaron Wildberger, Ben Irani, Carl Schalansky, and Ryan Kim shown with an Internal Model of an sCO<sub>2</sub> Heat Exchanger, an actual sCO<sub>2</sub> Heat Exchanger, a Hydrogen Pre-Cooling Heat Exchanger, and the Diffusion Bonding "Gator" Furnace behind them.



To learn more about the TCF, visit <https://energy.gov/technologytransitions/services/technology-commercialization-fund>

## Sandia and Goodyear Celebrate 25-Year Partnership

In 2017, the collaborative relationship between Sandia National Laboratories and The Goodyear Tire & Rubber Company was recognized for its longevity and success with celebratory events. It's now been 25 years since Goodyear first approached Sandia to partner on designing the complex systems needed for high-performance tires.

"You might wonder how national defense systems relate to tire engineering," said Susan Seestrom, Sandia's chief research officer. "But a tire is a complex system—one of the most formidable challenges in computational mechanics—and that's something Sandia knows well."

Chris Helsel, Goodyear's chief technology officer said, "Our computational work with Sandia is a continuous source of competitive advantage for Goodyear, helping us design and deliver high-performance products and services in a digital economy."

"It's often surprising to people to learn just how complicated it is to model and simulate tire performance, considering millions of material combinations and permutations and blending structural mechanics, rigid body and fluid dynamics under varying temperature, pressure, and wear conditions," said Dale Moseley, Goodyear's global project manager.

The collaboration allows Sandia to enhance its software toolkits and improve its capabilities for mission applications while simultaneously addressing Goodyear's proprietary challenges. Goodyear credits its work with Sandia for reducing new product development times, improving manufacturing methods, and lowering both technical and operational costs, all contributing to a competitive advantage in a complex industry.

The work with Goodyear led to a deeper appreciation at Sandia of the value of computer modeling in the early stages of development. Ted Blacker, Sandia's manager of Simulation Modeling Sciences said, "Our computational tools typically were used late in the process to understand why something broke and how to fix it. Now we use modeling more in the upfront stages, such as in the early design, to reduce testing."



Sandia and Goodyear teams at a 25-year partnership event.



## Innovation and Intellectual Property Celebration

Sandia National Laboratories' Integrated Partnerships Organizations hosted the 8th annual Innovation and Intellectual Property Celebration on December 7, 2017. The annual event honors the innovative culture and intellectual property generated by Sandia's scientists, engineers, and technologists.

Awards were given to 140 inventors for granted patents in calendar year 2016 and 84 copyright authors for copyrights asserted in calendar year 2016. The event also recognized 47 Mission Innovators, who were nominated by their divisions for innovation in support of Sandia's national security missions.

Awards were also presented to 16 director-nominated Up & Coming Innovators, honoring early career Sandians who exhibit entrepreneurial talent, develop unique solutions to complex scientific challenges, and display potential to make significant contributions to the Labs' intellectual property portfolio.

Former Sandian Dan Neal was recognized as the 2017 Entrepreneurial Hall of Fame honoree. Neal left the Labs to start a company called WaveFront Sciences based on wavefront sensing metrology technology licensed from Sandia. Commercialized by WaveFront Sciences, Abbott, and Johnson & Johnson Vision, this technology has helped to improve vision for over one million patients.



Johnson & Johnson Surgical Vision, Inc. Research Fellow Dan Neal, and Sandia Associate Laboratories Director & Chief Research Officer, Advanced Science and Technology, Susan Seestrom.

## NMSBA Innovation Celebrations



Projects that achieved outstanding innovations through the New Mexico Small Business Assistance (NMSBA) Program in 2016 were honored at five Innovation Celebrations in 2017.

Three of these projects received technical assistance from Sandia. Biophagy, a biopharmaceutical company, was able to gain access to specialized imaging equipment and expertise. Critical Utility Base—customized, transportable utilities—received engineering assistance with automating their racking system. iGs Designs got help with evaluating and testing their embroidery machine thread guide tool.

One project received the "Honorable Speaker Ben Luján Award for Small Business Excellence" for demonstrating the most economic impact. Old Wood, an environmentally conscious manufacturer of wood flooring was able to begin a new firewood division due to lean manufacturing consulting.

NMSBA assists for-profit small businesses in New Mexico with access to laboratory experts at Sandia and Los Alamos national laboratories. These experts help them gain knowledge and solve challenges utilizing the labs' cutting-edge technologies.

Old Wood receives the Ben Luján Award.

Sandia National Laboratories was recognized with awards this year for achievements in technology development, technology transfer, and technology partnerships.

## R&D 100 Awards

The R&D 100 Awards identify and celebrate the year's 100 most innovative technologies. Sandia competes with universities, corporations, and other government laboratories for these prestigious awards.

### Microgrid Design Toolkit

This decision support software generates the information needed to create optimized preliminary microgrid designs that can provide economic value during normal operations and power when the utility is unavailable.

### SolidSense "Gas Analyzer on a Chip"

A robust sensor platform that provides exhaust chemistry feedback for engines, power plants, and other applications, SolidSense can be used to improve fuel efficiency and reduce emissions.

### Ultra-Wide Bandgap Power Electronic Devices

These devices would replace today's silicon-based high-voltage transistors, enabling next-generation power electronics that are ten times faster and ten times more compact than today's state-of-the-art.

### Control System for Active Damping of Inter-Area Oscillations

This system improves electric power grid reliability by continuously damping inter-area oscillations, allowing greater power transfer and enabling the future smart grid.

### High-fidelity Adaptive Deception & Emulation System (HADES) Platform

HADES radically changes the way cybersecurity defenders protect their networks and gain insight on adversaries with a far richer deception than honeypots and other techniques.

## FLC Awards

The Federal Laboratory Consortium (FLC) Awards Program annually recognizes federal laboratories and their industry partners for outstanding technology transfer efforts.

### FLC National Awards

#### Excellence in Technology Transfer

##### SEARCH: The Selection, Evaluation, and Rating of Compact Heat Exchangers

Sandia's SEARCH software and micro-channel heat exchanger technology simplify designing efficient compact heat exchangers.

### State and Local Economic Development

#### New Jersey Transit Microgrid Research, Development and Deployment / TRANSITGRID

This project, the largest microgrid by capacity and geographical footprint in the U.S., will provide reliable power to protect public transportation infrastructure from disruptions caused by natural or man-made disasters.

### FLC Mid-Continent & Far West Region Awards

#### Excellence in Technology Transfer

#### Advanced Nanomaterials for Energy Conservation and Temperature Regulation

IR Dynamics is working with Sandia to create tunable thermochromic nanoparticles triggered by the environment to control solar heat gain. The nanoparticles can be incorporated into windows, architectural plastics, and athletic clothing.

#### Outstanding Commercialization Success

#### SpinDx and the Trak® Male Fertility Testing System

Based on Sandia's SpinDx portable lab-on-a-disk diagnostic technology originally developed for biodefense but now being developed for multiple commercial applications.

#### Notable Technology Development

#### Neuromorphic Cyber Microscope

The small Cyber Microscope mimics the brain's ability to process large amounts of data to protect computer systems from cyberattacks. It is more than 100 times faster and 1,000 times more energy-efficient than conventional cybersecurity systems.

#### Outstanding Technology Development

#### SmartLAMP

A smartphone-controlled, battery-operated point-of-care diagnostic device that weighs less than a pound, costs as little as \$100, and can detect Zika and other vector-borne diseases rapidly and accurately.

#### Regional Partnership

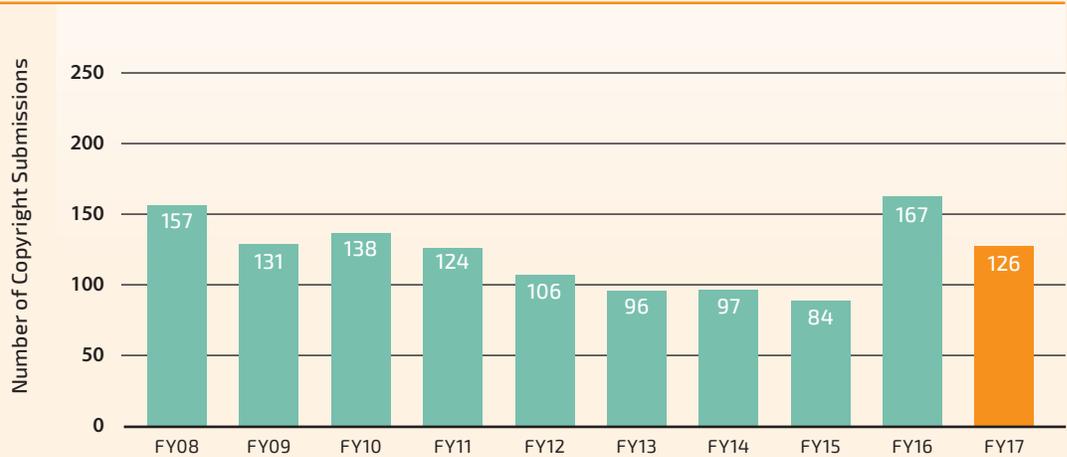
#### National Rotor Testbed: Using Large-Scale 3D Printing to Test New Wind Blade Designs

Sandia worked with Oak Ridge National Laboratory and TPI Composites to 3D print wind turbine blade molds. This reduces both cost and time for manufacturing new wind turbine blade designs, speeding adoption of innovative wind energy technology.



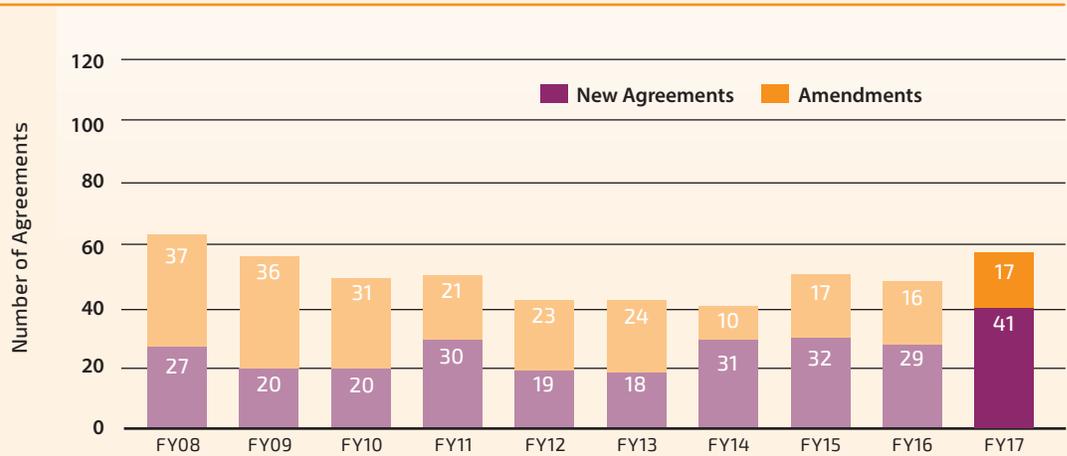
## Copyrights

### Copyright Submissions

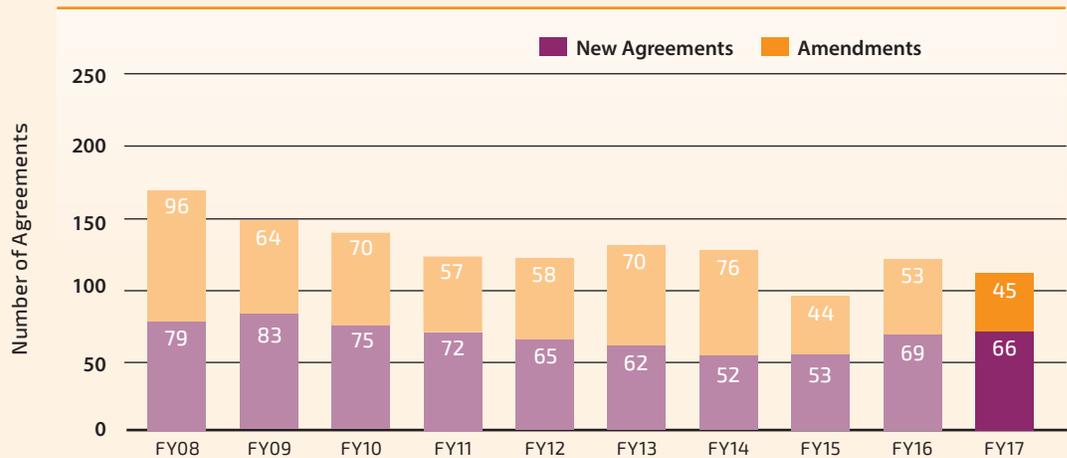


## CRADAs and SPP/NFE Agreements

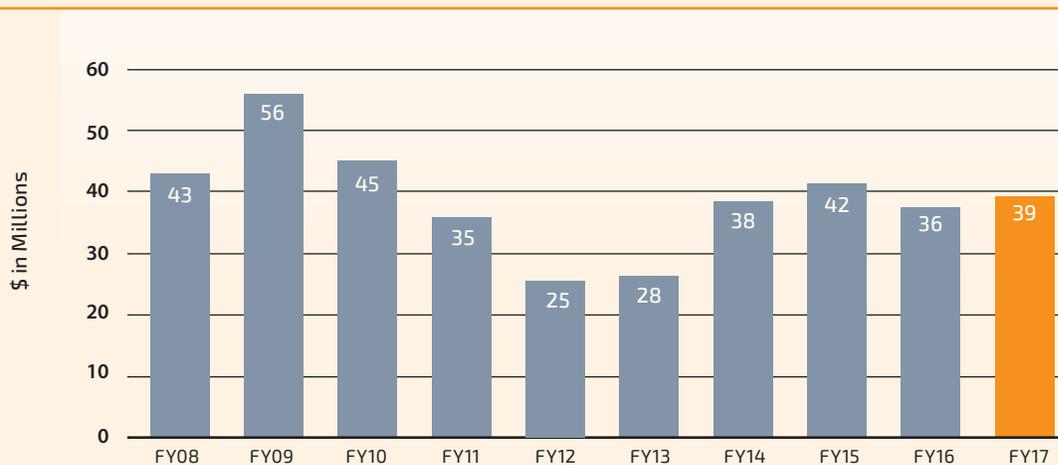
### Cooperative Research and Development Agreements (CRADAs)



### Strategic Partnership Projects/Non-Federal Entity (SPPs/NFE) Agreements

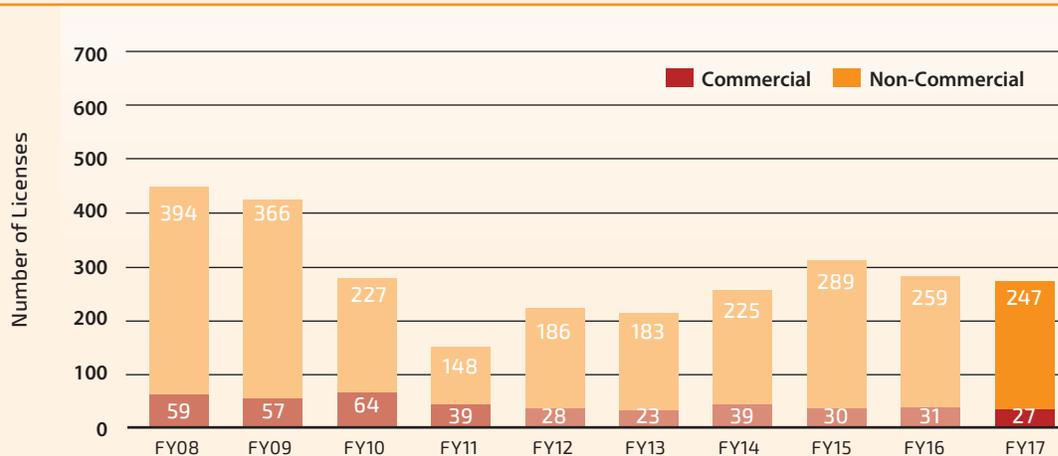


## Industry Funds-In Industry Funds-In to Sandia (\$M)

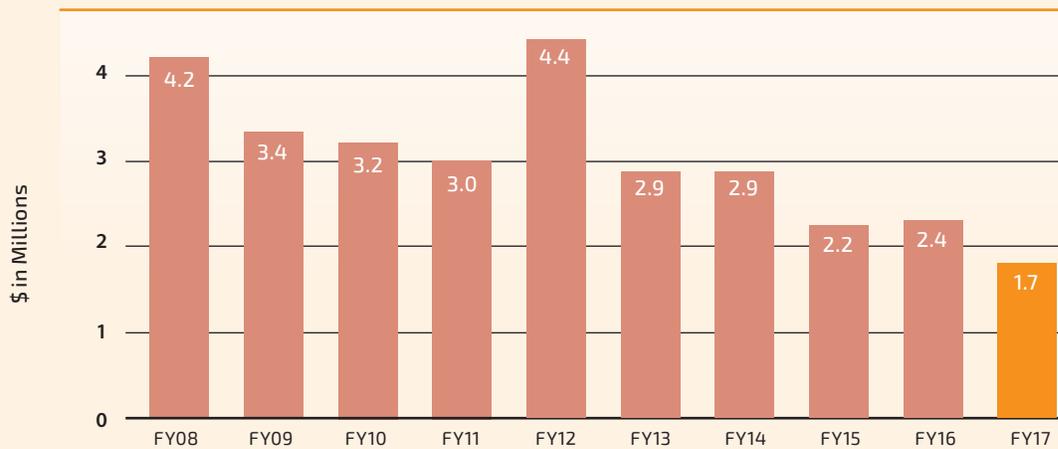


## Licenses

### Licenses



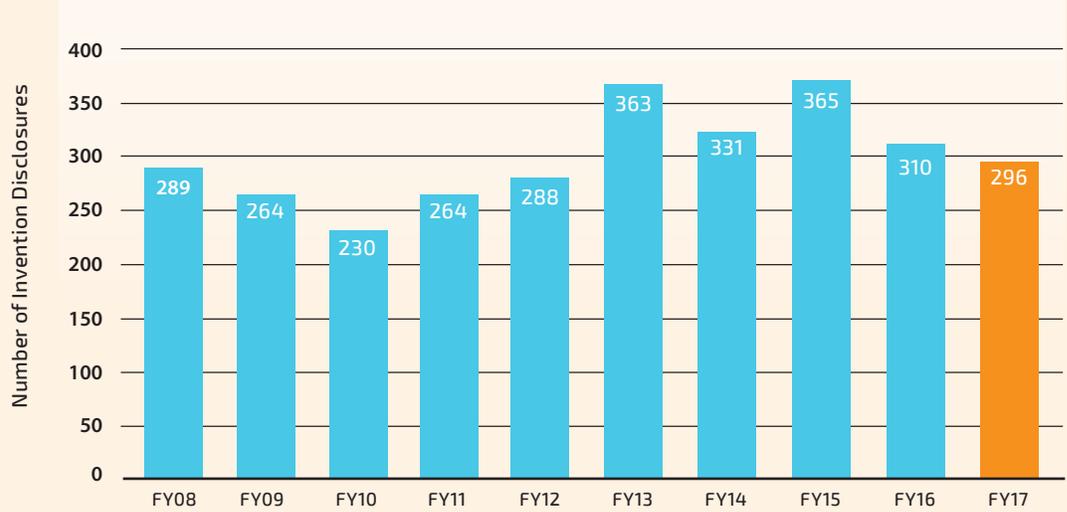
### Licensing Income (\$M)



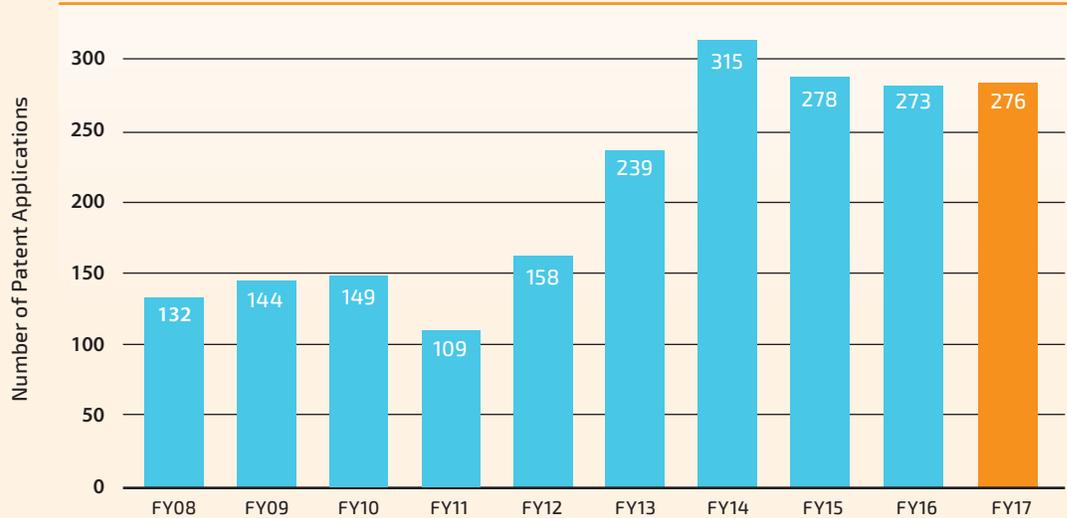


## Patent Activity

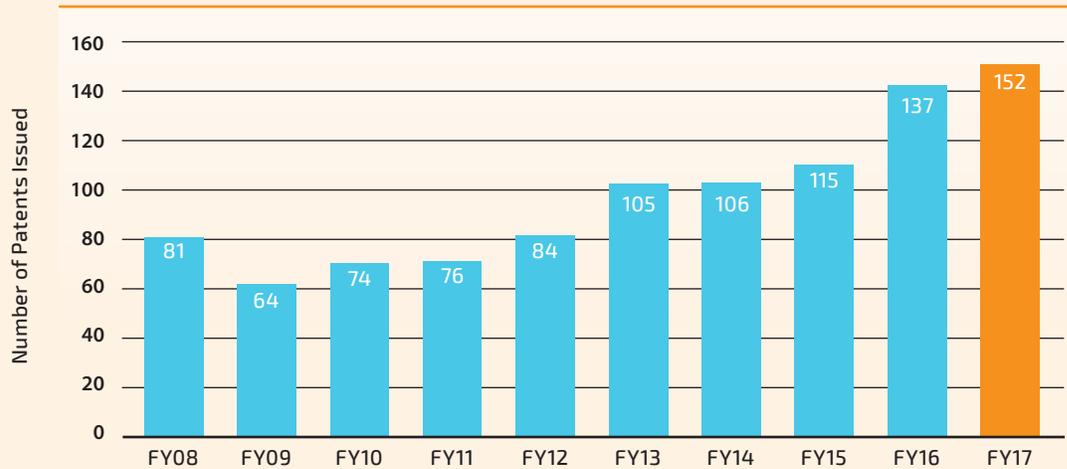
### Invention Disclosures



### Patent Applications



### Patents Issued



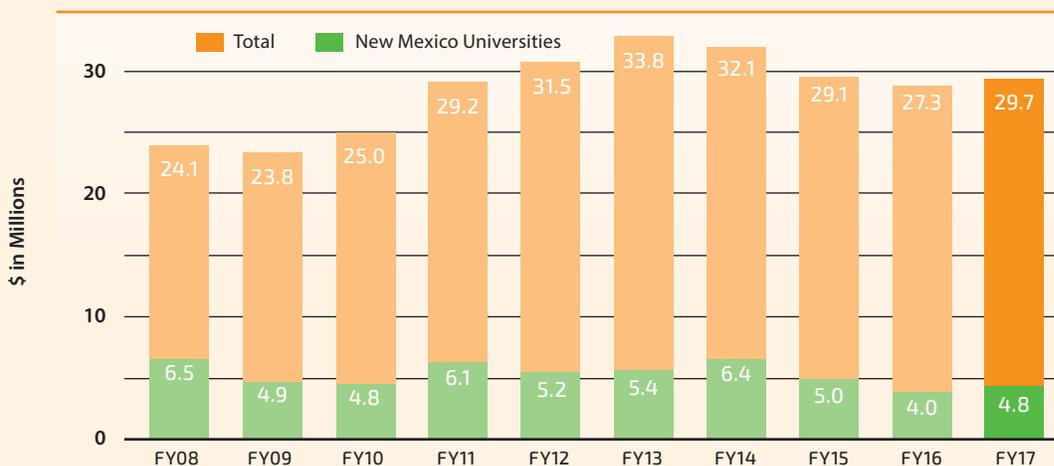
## University Partnerships

Since 1997, Sandia National Laboratories has formally contracted for university research to expand its science and technology base. Both Sandia and universities share a need to accelerate the creation of world-class research, develop scientists and engineers, and grow new competencies.

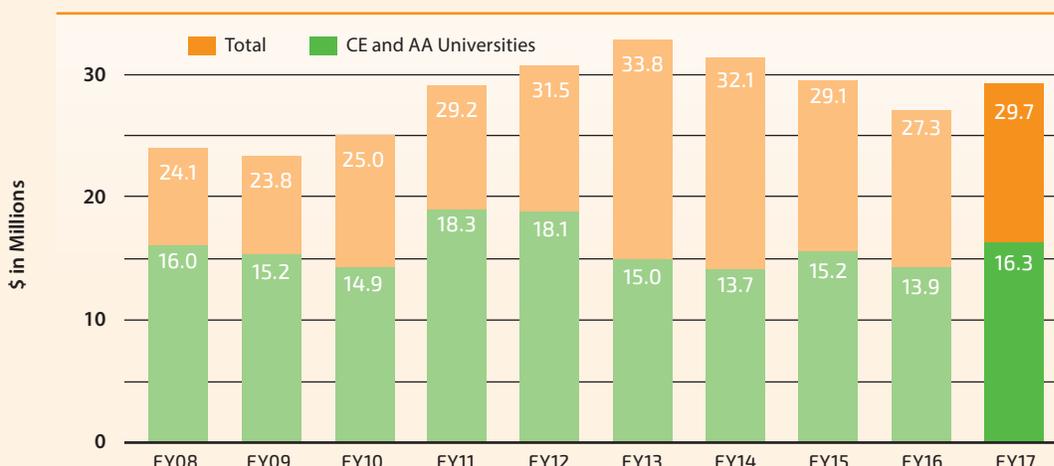
Sandia's university strategy encourages partnerships with various California, New Mexico, and national institutions. Through our Campus Executive program, we have formalized agreements with about 20 schools that define partnership goals, including research collaboration areas and talent pipeline objectives. In 2016, Sandia began more focused collaborations with a subset of the Campus Executive schools under its Academic Alliance program. These schools have had strong historical partnerships with Sandia, possess synergistic research competencies and capabilities, and share Sandia values and an affinity for national security work. They are working with Sandia to solve big problems, sustain and engage human capital, and accelerate adoption of new technology.

The University Partnerships Office, under the auspices of the Chief Research Officer, serves as the point of contact for university research issues and implements those processes that enable university partnerships.

**Investments in Research at New Mexico Universities**



**Investments in Research at Campus Executive (CE) and Academic Alliance (AA) Universities**



These programs pair Sandia executives with university officials at schools that share research interests and capabilities.



### Sandia Science & Technology Park (SS&TP)

Companies and Organizations .....	45
Employees .....	2059
Buildings .....	25
Public Investment in the Park* .....	\$89.0M
Private Investment in the Park* .....	\$295.8M
Total Investment in the Park* .....	\$384.8M
Increase in Tax Revenue* .....	\$2.6B
Increase in Wages* .....	\$4.4B
Average Salary of Full-time Jobs in Park .....	\$83K
Average Salary of Full-time Jobs in Metro Albuquerque .....	\$44K

\*Since Park opened in 1998.

#### 2017

Six companies and organizations moved into the Park: ComScire–The Quantum World Corporation, Diakonos Technology Group, Knowledge Systems (Sandia), New Mexico Angels, New Mexico Start-Up Factory, and Project Enhancement Corporation.



### New Mexico Small Business Assistance (NMSBA)

	<b>2000 - 2017</b>
<b>New Mexico Small Businesses Assisted</b> .....	2796
<b>Rural vs Urban Businesses</b>	
Rural (63%) .....	1775
Urban (37%) .....	1021
Combined .....	2796
<b>Dollar Amount of Assistance</b> .....	\$57.9M

**Return on Investment (ROI)** .....

*(ROI is based on salaries of jobs created and retained.)*

#### Economic Impact

Small Business Jobs Created and Retained .....	6858
Average Reported Salary (2016) .....	\$44K
Increase in Revenue .....	\$326M
Decrease in Operating Costs .....	\$159M
Investment in NM Goods/Services .....	\$125M
New Funding/Financing Received .....	\$130M

\*Surveys are performed six months to one year after project completion.

#### 2017

Sandia invested \$2.4M helping 188 small businesses in 21 counties throughout New Mexico. There were 61 Sandia principal investigators across 46 departments that supported NMSBA.



### Entrepreneurial Separation to Transfer Technology (ESTT)

<b>Sandians Who Left on ESTT*</b> .....	158
To Start up a Company .....	71
To Expand a Company .....	87
<b>Companies Affected by ESTT*</b> .....	109
Start-up Companies .....	55
Expansion Companies .....	54

\*Since ESTT began in 1994.

#### 2017

Five employees took the skills and expertise they acquired at Sandia and left on ESTT. Four left to start small businesses and one left to expand an existing business.



### Entrepreneur Exploration (EEx)

Events .....	46
Participants .....	2063

\*Since EEx began in 2015.

#### 2017

EEx held 20 events with a total of 926 participants.



Entrepreneur Exploration

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[www.sandia.gov/partnerships\\_reach](http://www.sandia.gov/partnerships_reach)

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